INVESTIGATION

Conclusions Using Indirect Evidence

An X ray of an injured hand reveals information to the trained eye of a doctor. A satellite image measuring the amount of reflected infrared light is used to predict the type and density of vegetation. Physicists smash gold atoms together in an attempt to better understand the origins of our universe. Each of these examples demonstrates how conclusions can be drawn from indirect evidence. In this investigation, you will generate plausible conclusions from indirect evidence by attempting to determine the shape of an unknown object without ever seeing it.

Problem

Determine the size, shape, and surface details of an unknown object by collecting indirect evidence.

Prediction

1. Read the Procedure section carefully.
2. Devise a method to obtain a numerical value describing how accurately your sketches predict the unknown object's features in terms of size, shape, and surface detail.
3. Suggest which feature of the object will be most accurately determined.
4. Suggest which type of feature will be most difficult to determine.

Materials

- test objects
- marbles
- board
- paper

Procedure

Working in small groups, determine the shape of a hidden object without ever looking directly at it. Your teacher will have placed a large board above an unknown object. Do not look under the board or attempt to see the object. Try to determine the size, shape, and as much surface detail as possible about the hidden object by rolling marbles under the board and tracking how they are deflected. Place a piece of paper on top of the board for sketching the paths of the marbles.

Collect as much data as possible in five minutes. Use the data to carefully sketch your group's idea of the appearance of the unknown object.

Trade positions with another group and repeat the process in an attempt to identify a second unknown object. Do not discuss your group's results with any other group at this point in the activity.

Analyze and Conclude

1. Describe how confident you are that the sketches accurately depict the hidden object. What gives you confidence in your conclusions?
2. Compare your sketches to the actual object. **(a)** Which feature of the object were you most accurately able to predict by using the indirect evidence provided by the motion of the marbles? **(b)** Which feature of the object were you least able to predict? **(c)** Suggest reasons for the increased error associated with the feature described in (b).
4. Is it possible to determine features of the object that are smaller than the size of the marbles you used? If not, suggest a technique that would allow the small features to be identified.

Apply and Extend

5. Make a list of scientific models that are based, either partly or entirely, on indirect evidence.
6. Make a list of technological applications that rely on interpretation of indirect evidence to function.

Adapted with kind permission from Elementary Particles and the Standard Model by Douglas Hayhoe.